Long-Term Autonomous Measurement of Ocean Dissipation with EPS-MAPPER

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LONG-TERM GOALS

The long-term goal of this project is to demonstrate the feasibility of making high-quality, autonomous microstructure measurements from an ocean mooring. Successful development of such an instrument would enable researchers to obtain information in situations not currently possible with ship-based systems.

OBJECTIVES

The objective is to develop a new proof of concept instrument called EPS-MAPPER (EPSONDE Moored Autonomous Programmable Profiling Epsilon Recorder). This will enable us to autonomously collect ocean microstructure profiles for periods of several weeks in both weak winds or in heavy weather conditions unsuitable for shipboard operations. This profiler merges two well-established instruments, EPSONDE (Oakey, 1988) and Seahorse™(Hamilton et al, 1999). The EPSONDE ocean-microstructure technology will be repackaged with modernized electronics and data logging memory and used as the payload for the Seahorse™ moored profiler.

APPROACH

The approach of this proposal is to develop the EPSMAPPER ocean microstructure profiler as a payload for the SeaHorse™ (Figure 1) to obtain estimates of mixing parameters. This instrument includes microstructure sensors to measure the dissipation using shear probes plus temperature microstructure using both a fast thermistor (FP07) and a thin film thermometer. The microstructure profiler is cushioned in flooded open cell foam in a gimballed mounting to decouple the SeaHorse motions from the profiler.

SeaHorse™ uses wave energy to move the profiler down a mooring wire to a docked position, typically 100m deep for our experiments. On a timed schedule, the package is released to free-float at typically 0.5 m/s to the surface. It is during this vertically rising profile that we measure mixing quantities. In addition to the microstructure measurements from EPSMAPPER, the package records data from a SeaBird 19Plus CTD. Velocity measurements are presently being evaluated using a Nortek Acoustic Doppler velocimeter mounted on SeaHorse™ in a collaborative study with Dr. Barry Ruddick at Dalhousie University.

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The long-term goal of this project is to demonstrate the feasibility of making high-quality, autonomous microstructure measurements from an ocean mooring. Successful development of such an instrument would enable researchers to obtain information in situations not currently possible with ship-based systems.

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Information from 1000 microstructure profiles from a depth of 100 meters to within a few meters of the surface can be recorded internally during the field program and downloaded when the mooring is recovered. This instrument is capable of recording one to three profiles per hour over a two to four week period after which time it would be recovered. At the same time, the information from the SeaBird 19 Plus CTD (sampled at 4Hz) and the Nortek ADV (sampled at 64 Hz) is recorded on another CompactFlash card by the SeaHorse controller and data logger. The data streams for all three instruments are synchronized using the SeaHorse microprocessor clock.

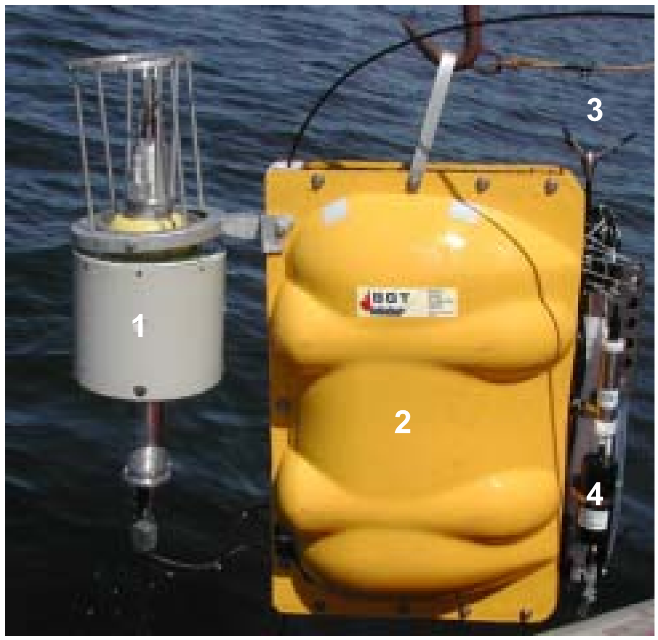

Figure 1: The EPSMAPPER (1) is shown mounted on the profiling engine SeaHorse™ (2) in tests in the Bedford Basin. The payload also includes a Nortek Vector ADV (3) and a Sea-Bird 19plus CTD (4).

WORK COMPLETED

The design and fabrication of the EPS-MAPPER electronic and mechanical components has been completed. The output of the 12 analog channels are converted to digital signals, processed and logged to a 1 GB CompactFlash disk. The system is controlled with a Persistor Instruments CF1 microprocessor which, in turn, has been interfaced with the microprocessor on the SeaHorse™ to allow synchronization of the data collected with the Sea-Bird CTD. The microstructure profiler is cushioned in flooded open cell foam in a gimballed mounting to decouple the SeaHorse motions from the profiler. Shear probes of a new design have been constructed to enable month-long deployments.

In October 2002, EPS-MAPPER will be moored at Station 2 on the Halifax Section of the Scotian Shelf (Figure 2) to do final tests of the prototype. This deployment will be one month in duration and will also include the Nortek Vector velocimeter as a payload on SeaHorse. A nearby mooring will

include an upward-looking ADCP to be used for inter-comparison of velocity estimates with the Nortek velocimeter data. This field experiment will provide a unique data set of coincident CTD, velocity and TKE dissipation measurements. We will analyse the microstructure data to obtain profiles of dissipation, ε, and temperature variance, χ_θ, in vertical segments of about two meters averaged in time over one to two hours. For these same vertical segments, we will use the density and horizontal velocity data to calculate gradient Richardson Numbers. These quantities will be used to explore the relationship between mixing rates and velocity shear, density gradient and Richardson Number. The relationship of mixing to surface forcing will be studied using wind data collected with a Minimet surface buoy at the mooring site.

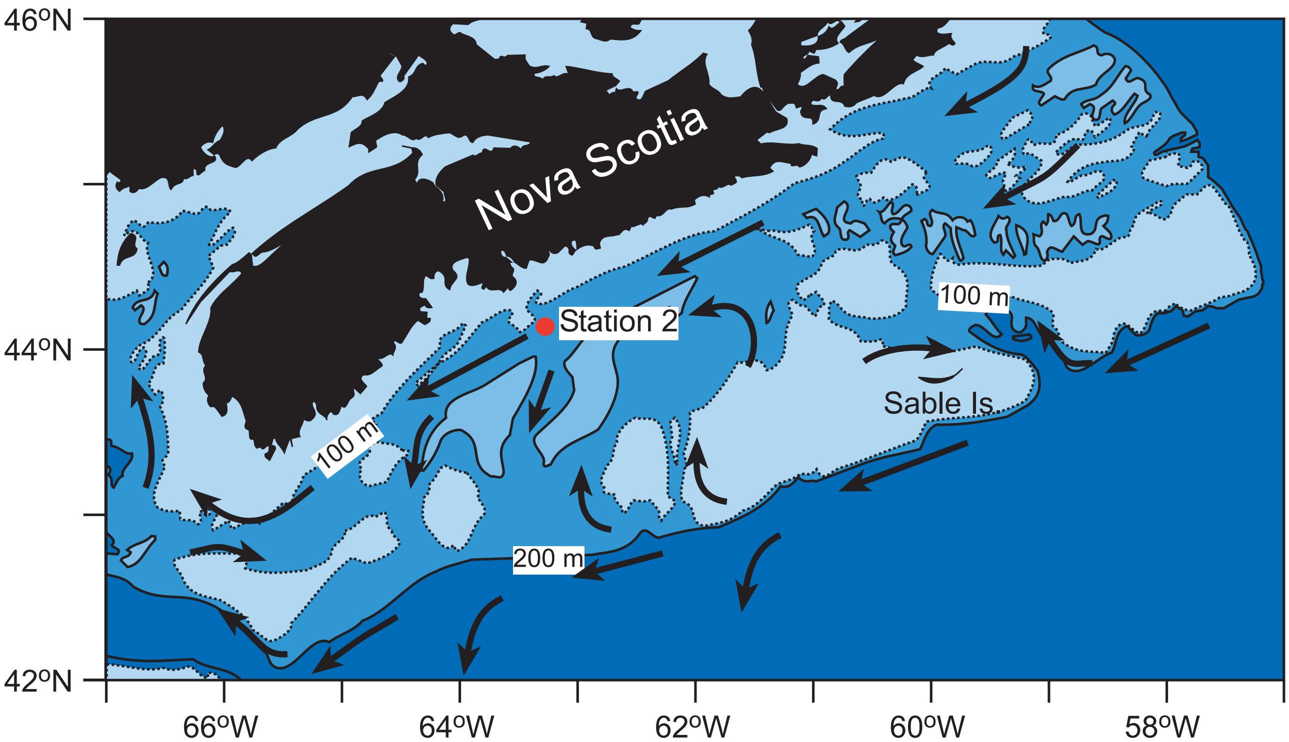

Figure 2: Station 2 (44.2677N, 63.317W, Depth 150 m). on the Halifax Section is the location of the October 2002 field experiment. The black arrows represent mean currents on the Scotian Shelf.

RESULTS

These shear microstructure sensors on the EPS-MAPPER profiler are able to measure viscous dissipation, ε, from levels less than 10^{-8} W/kg (limited by vehicle noise and vibration) to greater than 10^{-5} W/kg (limited by sensor size). This range of dissipations is suitable for studying mixing in the upper 100 meters on the continental shelf in all but the weakest mixing periods. The temperature sensors allow one to obtain the dissipation of temperature fluctuations, χ_θ. Temperature measurements will allow the measurement of dissipations less than 10^{-8} W/kg since they are not affected by vehicle vibration or noise.

IMPACT/APPLICATIONS

The potential impact for this novel instrument design is that it would provide a new way of making ocean turbulence measurements with potential for applications that are not feasible using the current ship-based systems. This would also be a much more economical method of making such measurements.

TRANSITIONS

RELATED PROJECTS

The October 2002 field program is being jointly funded by Fisheries & Oceans Canada and this ONR project. The inclusion of the Nortek Vector and Minimet buoy in the field program are being funded by a Canadian Foundation for Climate and Atmospheric Sciences (CFCAS) grant to Dr. Barry Ruddick at Dalhousie University.

REFERENCES

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